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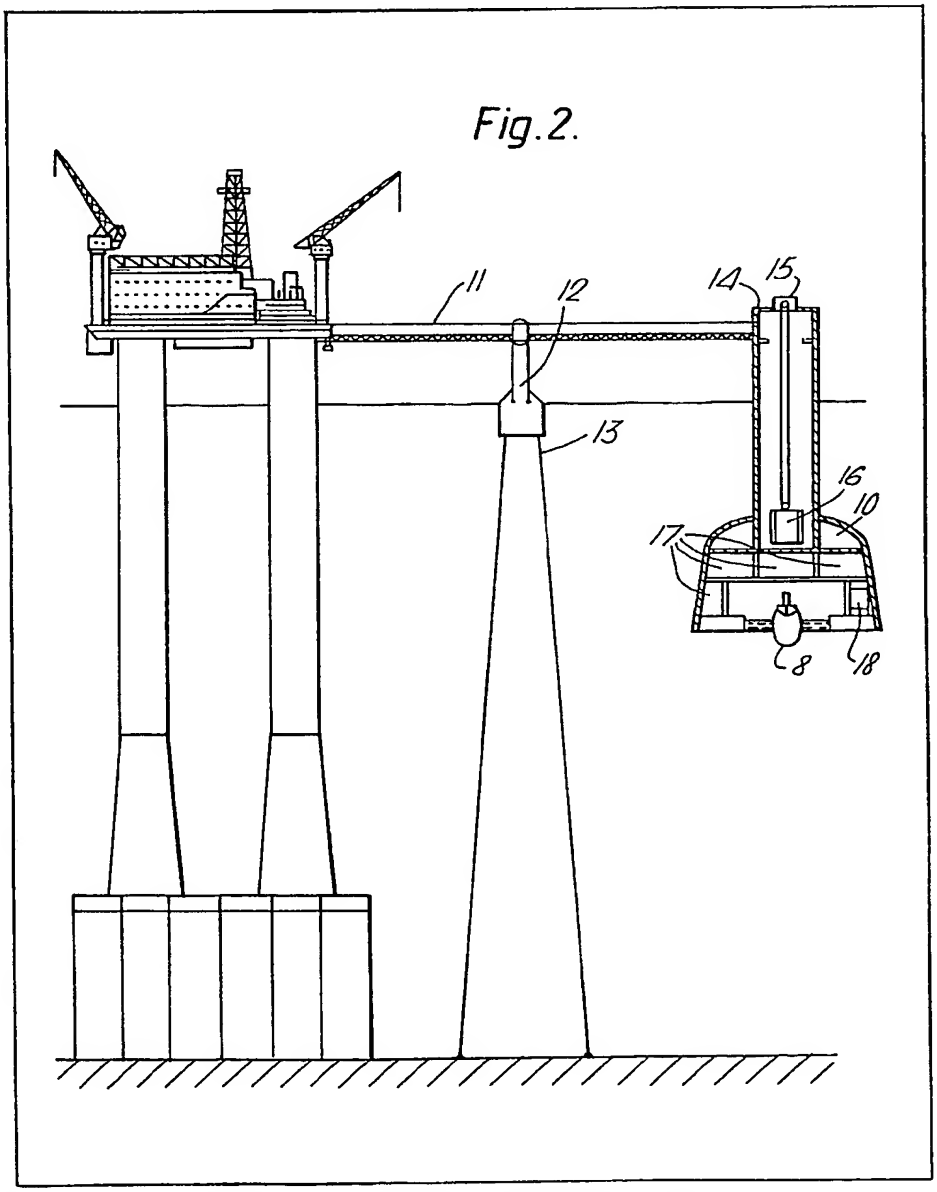
(54) **Docking facilities associated with off-shore installations**

(57) There is provided apparatus for servicing an off-shore installation comprising a semi-submerged dock positioned by the off-shore installation and equipped with means for docking a submersible service vessel 8. The dock is connected to a covered way 11 by a lift shaft 14. The covered way is supported by a tethered buoy 12 or the dock is supported from the sea bed. Alternatively, the dock is in the form of a jack-up rig having releasable connection to the installation. The dock has air locks 17 between the docking area and the shaft. The submersibles are adapted or special submarines with cargo hatches, or submersible tugs.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig. 1.

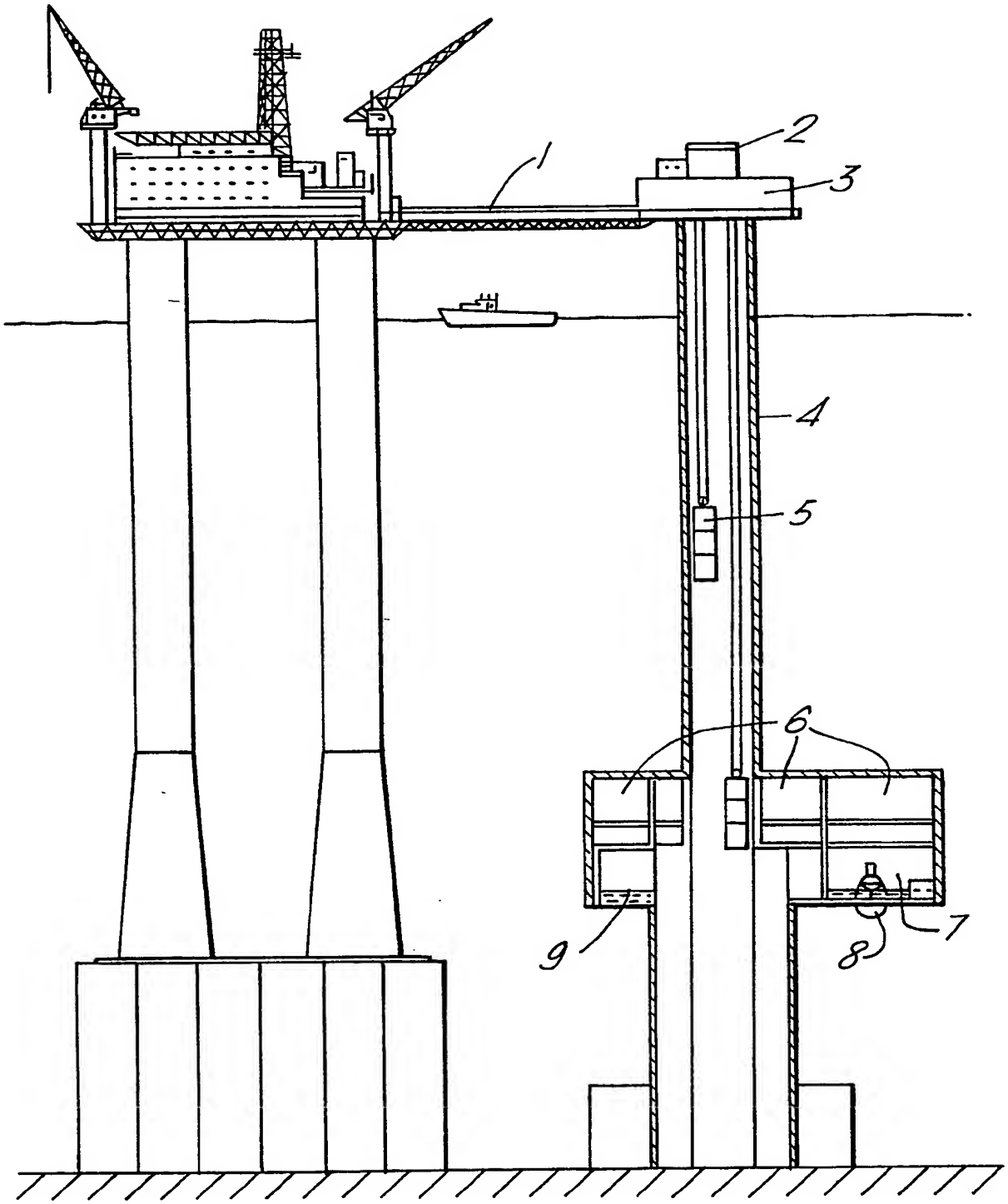


Fig.2.

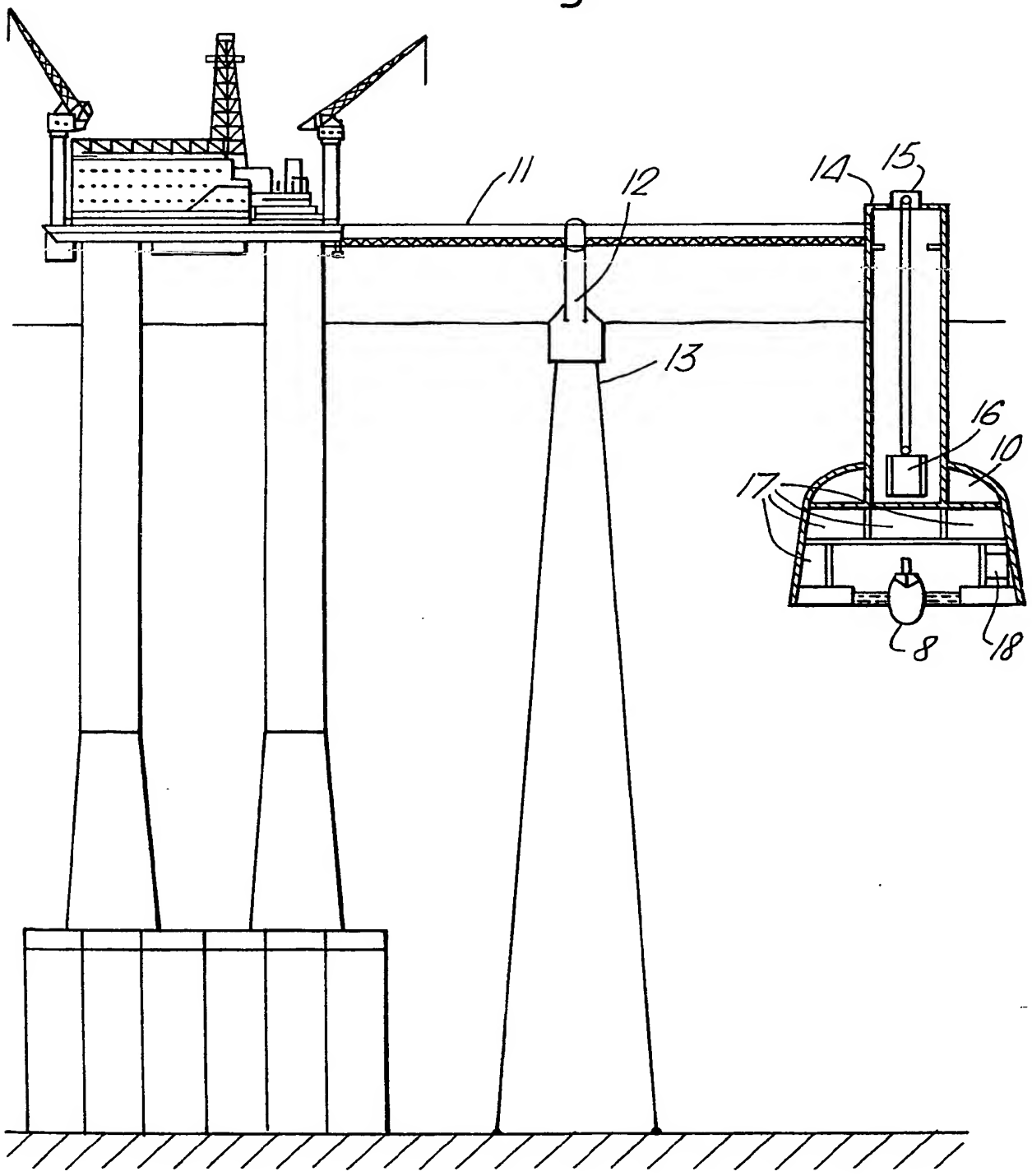


Fig. 3.

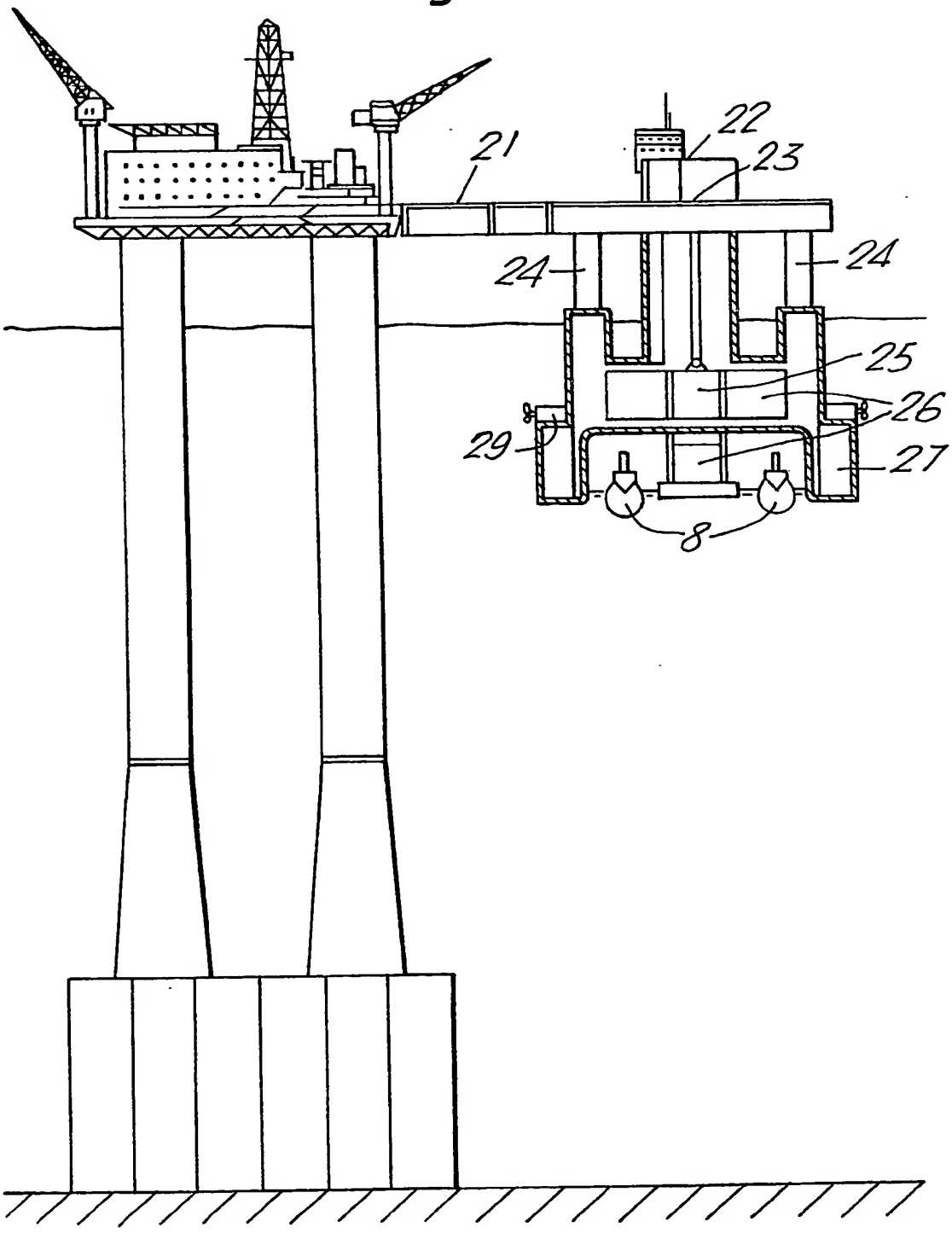
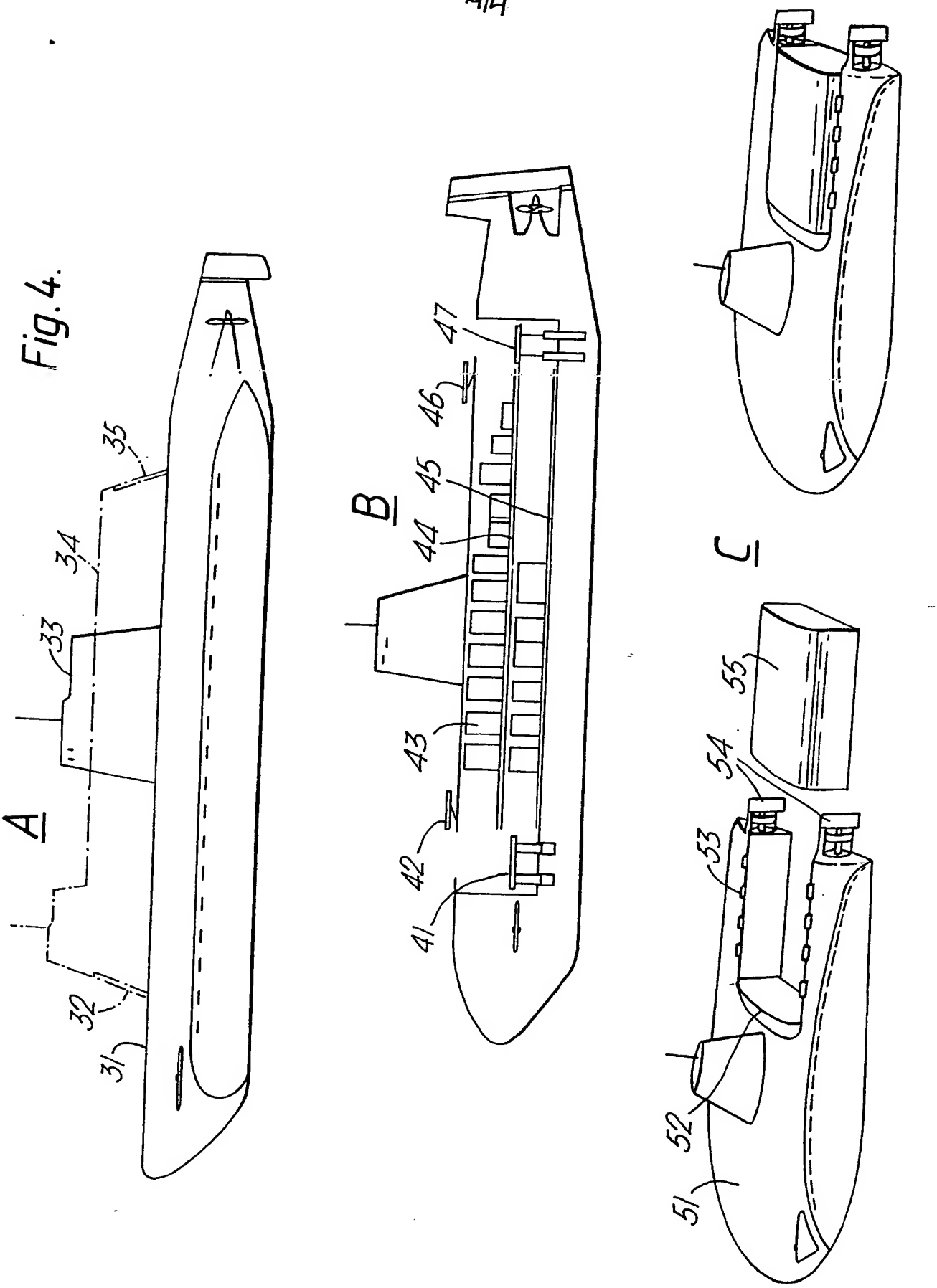


Fig. 4.



SPECIFICATION

Meth d and apparatus for supplying off-shore installations

The invention relates to means for and methods of supplying off-shore installations etc., by use of a semi-submerged structure and cargo/passenger submersible vessels whereby use is made of the reasonably stable conditions at depth to ensure regularity of supply irrespective of weather conditions on the surface, which restrict the use of helicopters or surface vessels, and endanger the crews and installations in conditions of poor visibility, strong or gusting gales, and heavy swell sea.

The apparatus and methods proposed have the further advantage of allowing evacuation of the installation in the case of fire or explosion on the installation, where there is extreme hazard to rescue by air or sea, further the structure proposed can be used as an underwater safety and rescue base for divers on routine inspection and servicing work on the well heads or main installation structures.

A preferred embodiment of the invention to be described in detail hereinafter provides for a structure of large diameter, tubular shape, made of concrete, steel or other durable material, with a cup or bell shaped end of a size suitable to allow inside the docking of submersible cargo/passenger carrying vessels. The design of of the structure can be varied for the type and size of installation to be serviced, for example it may be desirable that the tubular column extend from above the water level to the sea bed and the cup or bell shaped docking area be attached to the side of the column and positioned anywhere between the sea bed and water level, alternatively, the cup or bell shaped portion of the structure with the tubular column rising vertically from it to above sea level may be in a semi-submerged position with the cup or bell shaped docking area again anywhere between surface and sea bed. The structure is located in reasonably close proximity to the off-shore installation and linked to it by covered carriageway, where the structure proposed is direct to the sea bed positional relationship is fixed but in the case of a semi-submerged structure position will require to be maintained by use of computer controlled position stabilisers such as are used on semi-submersible exploration rigs or drill ships, or anchor positioning for location may be used.

The columnated part of the structure previously described carries the means of transferring persons and materials from surface to the underwater docking area, this means may be of lift cage type, platform movement by crane or derrick, or any suitable alternative, preferably there should be two means of rise and fall lifting within the tubular column and an internal spiral walkway or ladder system for safety purposes. The structure must be pressurised to prevent water entry and there are various alternatives which can be used, for example the bell or cup shaped docking area only may be pressurised and an air lock system used between the docking area and the tubular column, alternatively both column and docking area be pressurised and air locks used at the surface end of the column, and to ensure safety it may well be advisable to pressurise both docking and column areas with air locks at both.

Preferred embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is an illustration of surface to sea bed structure, with side attached submersible docking facility linked to a production drilling platform;

Figure 2 is an illustration of a semi-submersed structure with the submersible docking facility directly below the tubular column;

Figure 3 is an illustration of a semi-submersible structure, for temporary use, which can operate pressurised or unpressurised, but is close to surface; and

Figures 4A, B and C are illustrations of cargo/passenger submersible vessels.

Figure 1 shows a surface to sea bed structure with side attached submersible docking facility, linked to a production platform by a covered way 1 supported on a girder construction and capable of supporting mechanical handling vehicles and their loads. A winch house 2 for raising and lowering lift cages 5 from the sea bed to the deck and transport area is mounted on a deck and transport area 3 where cargo from or to the submersibles awaits transport across to the production platform or down the main shaft 4 which forms the main hollow column or structure. This can be made of metal or other materials and may be built in sections similar to the method of contructing proposed for off-shore structures by Craig Smith & Associates known as the Ecosafe method.

Air lock compartments 6 effectively seal off the structure from pressurised compartments 7 and 9 which are open to allow entry and exit of the cargo submersibles 8 into the docking area 7, a smaller docking facility 9 being provided for divers or Mini-subs used for inspection or other duties.

A semi-submersed structure with a bell shaped or alternative shaped docking area in suspension between sea bed and surface is shown in Figure 2. A covered transport way 1 to the production platform is supported by a buoy or structure 2 held in position by mooring chains or cables linked to the sea bed for permanent positioning, the covered transport way extends then from the buoy to semi-submersed structure 4. The structure 4 has a winch house 5 for raising or lowering lift cages 6 from the docking area 8 to the structure deck. The lift cages 6 transfer cargo or personnel to and from the deck to docking area 8. Air lock compartments 7 are provided to ffectively seal off the main structure from the docking area 8. For added safety, air locking lifts could be used to transfer cargo from the docking area 8 to the main air locks 7, to further ensure that the pressurised area/docking area for the cargo submersibles is separated from the lift shaft. An ar a 10 around

the top of the docking area houses the flooded ballast tanks and the position maintenance drives. The advantages in this structure are that there are no cables or mooring chains, or extended structure to foul an incoming submersible, the use of a midway buoy on the linked way keeps the submersibles away from the production platform, and position is maintained by computer controlled positioning motors using satellite information.

Figure 3 is another illustration of a semi-submerged structure with a capability rather akin to a jack up type drill rig, and the capability of self propulsion for movement between a number of production platforms located in an area. An extending covered transport way 1 can be extended from the structure to the platform deck from some distance away, and can be raised or lowered to different heights by jack up legs 4. The bridge and control area 2, also crew quarters is located above the winch house 3 for the lift cages 5. Air lock compartments 6 separate the pressurised docking area where submersibles 8 load and unload, from the riser shaft. Flood ballast tanks 7 are provided each side of the docking area together with power sources for the positioning and propulsion units 9, which again maintain the position of the structure by satellite information and computer control.

Figures 4A, B and C show various forms of cargo/passenger submersibles. Figure 4A illustrates the conversion of a conventional submarine by removing the original conning tower 3 from the deck 1, then adding a cargo/conning tower assembly shown in dotted lines on a strengthened deck with two air and water tight cargo doors 2 and 6. Figure 4B illustrates a specially built submersible with two cargo carrying decks or more, cargo 3, containerised or otherwise is lowered through water tight cargo doors 2 and 6 by platform lifts 1 and 7 to decks 4 and 5 then moved up a central gangway by mechanical handler or conveyor to side stowages each side. Figure 4C illustrates a special submersible towing vessel, the tug 1 has clamping rams 3 on each side and is driven and steered by motor rudder units 4 the cargo tank/container is a large water tight structure with ballast tanks which are linked up to the submersible tug unit and are capable of being flooded or blown from the tug unit. A number of tank/container units can be made available for the purpose of bringing a cargo laden tank/container from port to any of the structures shown in Figures 1, 2 or 3, by means of the submersible tug which travels on the surface at high speed until it is close to the submerged docking structure when it then transfers from normal oil fuel to electric power, submerges and enters the submerged docking area and surfaces therein. The cargo tank/container is then released and moored to the submerged dock for unloading at leisure, the return container is then connected, passengers or relief crews which travel in the quarters provided in the tug are unloaded and loaded, water tight procedure is adopted, the tug with container submerges from the docking area and either surfaces away from the structure for high speed surface travel or remains running submerged if the weather is poor until it is near port.

The illustration of the submersible tug is a generalisation of one method only for supplying an off-shore station from port, there are other methods, for example, the tank/container for cargo could be deck loaded onto the submersible and removed or loaded by crane or winch, or container handling device as used in many dock areas. Another example is that the tank/container unit as shown in Figure 4C becomes a fixed section of the submersible, with large water tight door or doors on top or sides to allow entry and exit of cargo containers by lifting or lowering from the previous mentioned methods or allowing mechanical handling devices such as fork lift trucks to enter from the sides, front or rear, to remove or position cargo containers.

The structures and vessels described above are particularly suitable for carrying out the method in accordance with this invention whereby off-shore structures of any type located in depths of water suitable for operating submersibles can be serviced and supplied by use of cargo/passenger carrying submersible vessels in any weather conditions, by day or night, by the use of a submerged pressurised, or if close to the surface, unpressurised docking and loading facility although other structures and vessels may be used.

CLAIMS

1. Apparatus for servicing an off-shore installation comprising a semi-submerged dock positioned by the off-shore installation and equipped with means for docking a submersible service vessel.

2. Apparatus for servicing an off-shore installation, substantially as hereinbefore described with reference to Fig. 1, Fig. 2 or Fig. 3 of the accompanying drawings.

3. A submersible service vessel constructed and arranged substantially as hereinbefore described with reference to Fig. 4A, Fig. 4B or Fig. 4C of the accompanying drawings.

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